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Received 19 June 2009; accepted 11 February 2010

Natural history notes on the Eastern Blue-tongued Skink *Tiliqua scincoides scincoides* from the basalt plains around Melbourne

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Abstract

Data and observations are given on the appearance, size, habits and diet of 163 Eastern Blue-tongued Skinks *Tiliqua scincoides scincoides* inhabiting the basalt plains grasslands to the north and west of Melbourne. Blue-tongues possessed an average of seven dark body bands (5 – 9; n = 90) and seven dark tail bands (4 – 10; n = 79). Snout-to-vent lengths ranged from 76 to 340 mm (n = 108) and mass from 8 to 545 g (n = 68). Juveniles had relatively narrower heads compared to adults. Blue-tongues were active in all months of the year except winter. Surface stones were the main refugia available and were used by Blue-tongues throughout the year. Parturition occurred from February to April (n = 11). Blue-tongues fed on a variety of endemic and introduced fruits and arthropods. Based on the monthly variation of body sizes and a low number of recaptures, sexual maturity is probably not attained until at least two years of age. (*The Victorian Naturalist* **127** (3), 2010, 70–78)

Keywords: Blue-tongues, basalt plains, size, habits, activity

Introduction

The Eastern Blue-tongued skink *Tiliqua scincoides scincoides* is a readily identifiable, widespread species that only relatively recently has been the subject of ecological research (Koenig *et al.* 2001, 2002; Christian *et al.* 2003). This is despite its being the first Australian reptile to be formally named (Shea 1993a), its ability to live in highly modified human environments (Koenig *et al.* 2001), and its commonness and occurrence in nearly all natural habitats in eastern Australia (Shea 1998; Cogger 2000; Wilson and Swan 2003). Historically the species occurred throughout much of the Melbourne area, from woodlands east of the city, through the open Red Gum woodlands to the north, and the treeless grasslands to the west (Schulz *et al.*

1991; Larwill 1995; Museum Victoria 2006). Blue-tongues were very common on the basalt plains to the north and west of Melbourne; indeed Fleay (1931: 9) noted that 'In the stone walls of Laverton and Werribee, I have often collected more Blue-tongues than snakes'. Snakes remain very common in these areas, where sufficient ground cover exists, and so too are Blue-tongues (Larwill 1995; pers. obs.). The native grasslands and grassy woodlands that once covered the basalt plains have undergone a drastic reduction in area due to expanding residential, industrial and agricultural developments, making the lowland temperate grasslands one of the most critically endangered ecosystems in Australia (Ward 1966; DCE 1990; Lunt 1991; McDougall and Kirkpatrick 1994). Notes on the natural history of *T. s. scincoides* gathered as part of a broader survey of basalt plains reptiles are detailed here.

Methods

Sites examined were located 15 to 25 km from the Melbourne CBD and consisted of remnant grasslands and grassy woodlands to the north and west of Melbourne's suburban fringe, primarily in the suburbs of Bundoora, Mill Park, Epping, Craigieburn, Deer Park, Laverton and Altona. All measurement data were gathered between 1990 and 1993, when there were 107 separate visits to sites, covering all months of each year and ranging in duration from 1 to 7 hours; on 92 visits at least one Blue-tongue was either sighted or measured. Some observations predate this period, the earliest being in 1983. During visits the ground surface was visually scanned and any noise indicative of movement in amongst grass tussocks was investigated. From suitable vantage points binoculars were used to scan potential basking sites. Surface debris (primarily basalt stone) was turned (and replaced), stone piles and crevices, and drystone walls were carefully inspected for the presence of reptiles. Blue-tongues were captured by hand, measured and carefully examined for approximately 15 minutes before being released. Snout-to-vent length (SVL), interlimb distance (ID; as measured by the straight-line distance from the axilla to groin), and tail length (TL) were measured using a 500 mm rigid wood-laminate ruler, and mid-body width (BW, when at rest) using a vernier calliper; all were measured to the nearest millimetre. In addition, head length (HL; from the tip of the snout to the posterior edge of the interparietal scale along the midline) and head width (HW; at the widest point) were measured to the nearest 0.1 mm using a vernier calliper, and mass (M) was measured to the nearest gram using an Ohaus spring balance. Reproductive status (gravid/non-gravid) and general condition (presence of ectoparasites, pre/post sloughing, scarring etc.) were noted. Sex could not be reliably determined at all in immature lizards, and even in adults is fraught with difficulty when based on external morphology (see Hitz and Ziegler 2004); only in about a third of adults was sex confidently assigned. Blue-tongues of either sex were deemed to be sexually mature if SVL ≥ 240 mm, based on data for Victorian and South Australian specimens in Shea (1992; 1993b). Neonates were identified by their fresh umbilical scars. Dorsal/ventral colouration, the number and pattern of dorsal/tail bands were recorded, and other individual identifying markings were noted. Faecal pellets produced by lizards during processing were retained and later examined. The longest (d_1) and shortest (d_2) sides and thickness of stones occupied by Blue-tongues were measured to the nearest centimetre using a flexible tape measure. Ambient temperature and substrate temperature beneath refuges were recorded (± 0.1 °C). As the introduced snake mite *Ophionyssus natricis* was present in populations, care was taken not to facilitate its spread, by avoiding the use of holding bags and by mist-spraying measuring instruments and hands with Orange-Medic™ after processing. Lizards were released at the point of capture.

Data for body size variables were bimodal, due to a 'gap' in the body size measurements (see below) and thus were not normally distributed even when transformed. However, when partitioned into sexually mature and immature size classes, the data were normally distributed; this was confirmed by the Shapiro-Wilk and D'Agostino-Pearson K^2 tests (Zar 1996). Data analysis of (non-partitioned) body size variables was therefore limited to non-parametric methods performed using SPSS (V.11), though none of the results was altered when performed using parametric methods. Data on refuge dimensions and numbers of dorsal/tail bands were normally distributed. Ordinary least squares regression was used to examine the quantitative relationship between pairs of body size variables, and the assumptions of this technique were checked. Both SVL and HL were used as independent variables where appropriate. Scatter-plots were first made between pairs of untransformed variables and then again for natural-log (ln) transformed variables. The Pearson correlation coefficient (r) and Spearman's rank correlation coefficient (r_s) were used (where appropriate) to assess the strength of the linear relationship between variables and the null hypothesis of no (linear) relationship was tested. A comparison of body size variables between the sexes was not performed due to the relatively low number of adults in which sex was confidently assigned. The chi-squared statistic was used to compare frequencies, with Yate's correction for continuity applied (Sokal and Rohlf 1995). The growth rate was calculated for a low number of recaptured lizards by dividing the change in SVL by the number of months between capture and recapture. Tests were one-tailed unless otherwise stated and deemed significant at the 0.05 probability level.

Results

One hundred and sixteen Blue-tongues were measured in the field, a further 47 were observed in the field but not measured, and the remains of eight dead lizards were located.

Appearance and size

There was considerable variation in both colouration and pattern. The number of dark body bands between the axilla and groin varied from 5 to 9 ($\bar{x}$ = 7.0, sd = 0.8, n = 90). The banding pattern varied greatly from smooth-edged solid straight bands to ragged-edged bands with intrusions of dorsal ground colour, bifurcations and thin longitudinal lines connecting adjacent bands. Dark tail bands showed greater variation in number, ranging from 4 to 10 ($\bar{x}$ = 7.0, sd = 1.3, n = 79) and in most individuals the bands merged towards the tip. The number of dark bands on the body and tail fall within the range of variation documented by Shea (1992) for southern and eastern populations of *T. s. scincoides*, though both mean values are at the lower end of this range. Nearly all individuals had an elongated blotch on the upper lateral edge of the neck identical in colour to the dorsal bands. The dorsal ground colouration exhibited relatively little variation and was either grey or yellow, with the latter more common (n = 69 vs 23). Ventral ground colouration ranged from bluish-grey (in specimens with grey dorsal ground colouration) to white, cream or yellow and various shades of orange. Typical ventral pattern was dark brown variegations (74%); dark brown flecks (18%) forming longitudinal lines towards the middle of the ventral surface (8%) were less commonly seen (n = 92). Twelve per cent of individuals had an unpatterned ventral surface (cf. 7.3% in Shea (1992)). In most individuals (87%) the underside of the tail differed in colouration from the ventral surface, being bright orange or yellow, usually clean, although there was sometimes a continuation of the dark (dorsal) tail bands onto this surface. All individuals possessed a prominent dark brown temporal stripe. Dorsal head colouration in nearly all individuals was the same as the dorsal ground coloration. The gular region was typically off-white and sparsely flecked with dark brown. Tongue colouration in adults varied from medium to dark blue; neonates all possessed dark blue tongues. In one adult the proximal third of the tongue was pure white and sharply demarcated from remaining dark blue.

Morphometric data for mature and immature Blue-tongues are given in Table 1. The largest individual had a SVL of 340 mm and a TL of 150 mm (mass not recorded); this SVL exceeded those of all museum specimens in the south-eastern states (Vic., SA, NSW; from data in Shea (1992)). The smallest individual was a neonate with a SVL of 79 mm, a TL of 33 mm and a mass of 8 g. The heaviest individual was a gravid female weighing 545 g while the heaviest non-gravid lizard was a female located mid-winter weighing 405 g.

Scatter plots of each size variable against SVL were strongly linear ($r_s^2 > 0.82$, $P < 0.0001$ in all instances) and consequently a linear ($y = ax + b$) rather than a power function model was used. The slope (a) and intercept (b) with standard errors (± se) were: BW 0.204 ± 0.0085, 0.9 ± 1.86 (n = 80); ID 0.699 ± 0.0105, –9.0 ± 2.24 (n = 77); TL 0.509 ± 0.0128, –7.4 ± 2.77 (n = 102). The natural logarithm of both mass and SVL was also strongly linear with regression equation: lnM = 2.86 ± 0.077 lnSVL – 10.3 ± 0.42 ($r_s^2 = 0.96$, $P < 0.0001$, n = 57); the 95% confidence interval for the slope was 2.71 – 3.02. The relationship between HL and HW was non-linear; however, transformation of HL produced a strong linear relationship with

Table 1. Morphometric data for Eastern Blue-tongues *Tiliqua scincoides scincoides*. Length measurements are in millimetres while mass is in grams. The mean, standard deviation (sd), maximum (max), minimum (min) values and sample size (n) are given. Abbreviations: SVL = snout-to-vent length, TL = tail length, HL = head length, HW = head width, BW = body width and ID = interlimb distance (see Methods for details).

	SVL	TL	HL	HW	BW	ID	Mass
Mature							
mean	270	130	38.2	37.8	55	175	282
sd	20.8	12.9	2.69	2.69	6.2	13.7	63.5
max	340	155	44.5	44.5	76	205	545
n	47	43	45	45	37	33	34
Immature							
mean	160	74	26.7	24.4	34	103	101
sd	44	24	4.69	5.87	10	33.7	78.2
min	76	33	19.3	13.6	17	43	8
n	61	59	50	52	43	44	34

regression equation: HW = 34.7 ± 0.72 lnHL – 88.8 ± 2.47 ($r_s^2 = 0.91$, $P < 0.0001$, n = 95; Fig. 1), indicating that larger Blue-tongues have relatively broader heads compared to smaller Blue-tongues.

The monthly distribution of SVLs exhibits a gap (between approximately 170 and 210 mm) that separates cohorts, the younger cohort consisting exclusively of immature lizards, and a presumed mixed-age cohort consisting of both immature and mature lizards (Fig. 2). The gap is evident from February to October inclusive. Few lizards with SVL < 200 mm were recorded in January and February. Six recaptured Blue-tongues had increases in SVL ranging from 21 to 162 mm, spanning periods from two to 14 months. The average growth rate varied from 7.3 mm/month to 13.5 mm/month, although the latter value was for a two-month period only. A growth rate of 11.6 mm/month was obtained for the longest period between recaptures.

Timing of reproduction

Only four gravid females were located in the field on 8, 9 and 28 January and 13 February. One post-parturient female was located on 28 February. Neonates were recorded from February through to April (n = 11: six in February, three

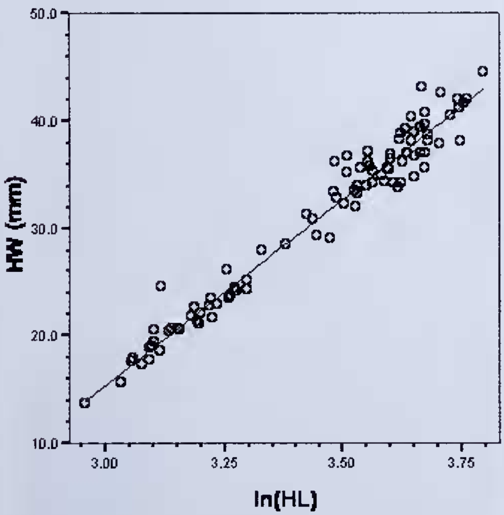

Fig. 1. Scatter plot of the head width (HW) versus natural logarithm of head length (HL) in Eastern Blue-tongues *Tiliqua scincoides scincoides* with regression equation: HW = 34.74 lnHL – 88.83 (r_s^2 = 0.91, n = 95).

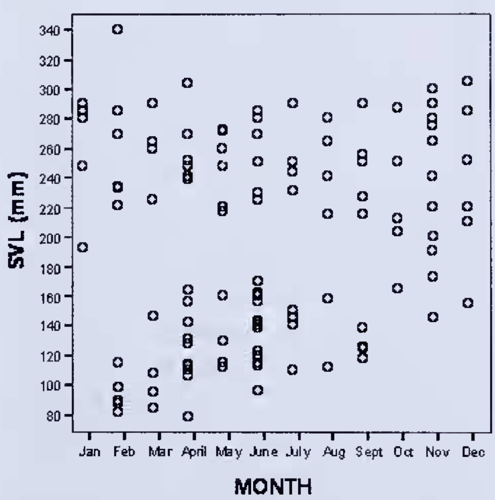

Fig. 2. Monthly distribution of snout-to-vent lengths (SVLs) of Eastern Blue-tongues *Tiliqua scincoides scincoides* (n = 116).

in March and two in April), indicating that parturition extends into autumn.

Habitat and refuge use

Blue-tongues occurred in a variety of habitats on the basalt plains wherever there was sufficient ground cover. Natural habitats included stony-rises with Hedge Wattle *Acacia paradoxa* /Black Wattle *Acacia mearnsii* /Drooping Sheoak *Allocasuarina verticillata*, River Red Gum *Eucalyptus camaldulensis* woodlands, Kangaroo Grass *Themeda triandra*-dominated treeless grasslands, escarpment lining creeks with Lightwood *Acacia implexa*/Tree Violet *Melicytus dentatus*, as well as intergrades of these. Highly disturbed habitats included pasture with surface stones gathered into piles or bordered by dry-stone walls, and former pasture/cropland invaded by exotic grasses and herbs such as Serrated Tussock *Nassella trichotoma* and Artichoke Thistle *Cynara cardunculus*. Common to all habitats was the presence of abundant surface stones. The intactness of the native vegetation seemed to have little influence on the occurrence of Blue-tongues, though few were recorded in dense stands of the introduced Gorse *Ulex europaeus* and Cape Broom *Genista monspessulana* in degraded northern grasslands, despite undisturbed stony ground cover. They were also uncommon in heavily grazed areas with minimal surface stone.

Refuge sites used by Blue-tongues largely seem to reflect availability. Surface stone was the most abundant surface refuge in the grasslands, and 82% (63 of 77) of all Blue-tongues recorded beneath ground cover were beneath stones. The remainder were located beneath artificial ground cover such as corrugated iron, linoleum and carpet. Fallen hollow limbs of River Red Gums *Eucalyptus camaldulensis* occurred sparsely in some grasslands but were not observed to be used by Blue-tongues. Some Blue-tongues over-wintered in cavities beneath stones that were abandoned burrows of the House Mouse *Mus musculus* (n = 5) and the Fat-tailed Dunnart *Sminthopsis crassicaudata* (n = 3). In three instances juvenile Blue-tongues were found curled-up inside the spherical grass nests of *M. musculus* in depressions beneath stones. The majority of over-wintering retreat-sites (76%) occupied by Blue-tongues had moist substrates (as opposed to either dry or wet). Four Blue-tongues were found over-wintering in flooded depressions beneath stones. One adult was located almost completely submerged with only its snout protruding as a result of winter rains flooding its retreat-site. The lowest daytime temperature recorded beneath an occupied refuge in winter was 9.3°C while in summer the highest temperature was 21.3°C.

Some Blue-tongues had dug through surface clay to gain access to over-wintering refuges beneath stones. This was indicated by their head and forelimbs being 'caked' in dry clay when discovered inactive during winter (n = 13). Furthermore, excavated soil was sometimes present at the edge of the stone (n = 9). When there was no visible surface entrance or gap, it seems likely that lizards gained access beneath stones through gaps that had since been closed up by the swelling of the surrounding clay soil. Blue-tongues also occupied loam soil cavities beneath stones in stony-rise habitat.

When inactive, Blue-tongues almost invariably assumed a curled up posture with the head and tail in direct contact (or nearly so). Lizards were typically semi-torpid and initially unresponsive to external movement when examined in winter, though they were responsive to touch (bloating and hissing were typical responses).

Eight species of reptiles and frogs were recorded beneath stones with Blue-tongues during winter months: Little Whip Snakes *Parasuta flagellum* (n = 8), Eastern Brown Snakes *Pseudonaja textilis* (n = 3), Striped Skinks *Ctenotus robustus* (n = 4), Striped Legless Lizard *Delma impar* (n = 1), Garden Skinks *Lampropholis guichenoti* (n = 2), Tussock Skinks *Pseudomoia pagenstecheri* (n = 3), Growling Grass Frogs *Litoria raniformis* (n = 2), Spotted Marsh Frogs *Limnodynastes tasmaniensis* (n = 6) and the Eastern Banjo Frog *L. dumerilii* (n = 1). In each instance the species were well separated (> 0.1 m) and it seems likely neither was aware of the other's presence.

While many different types of stones were used by Blue-tongues as refuges, particular stones were favoured and were nearly always occupied when searched. For example, a total of five adult Blue-tongues was recorded using one particular stone over a four-year period. The underside of the stone was concave and it was situated on a well drained, exposed, north-facing slope. It had been used frequently by Blue-tongues for at least ten years (pers. obs.). The stone only ever had one lizard beneath it at a time and often the same individual was recorded beneath it for several weeks during the active season and longer over winter. At least six other stones were repeatedly used by Blue-tongues.

The length of stones used by Blue-tongues ranged from 0.15 m to 1.50 m and the thickness from 0.04 m to 0.35 m (n = 48 for both). Mean dimensions (± sd) of refuges were 0.55 ± 0.24 m × 0.37 ± 0.11 m × 0.17 ± 0.08 m (n = 48 for each). SVL was significantly and positively correlated with length dimensions of stones but not with thickness (d_1: $r^2 = 0.10$, $P = 0.021$; d_2: $r^2 = 0.21$, $P = 0.002$; $r^2 = 0.00$, $P = 0.450$; n = 48 for each); however, two of these tests lack sufficient power. Thus, data are only suggestive of a tendency for smaller Blue-tongues to favour smaller refuges.

Diet

Information on the diet of Blue-tongues was obtained from the examination of faecal pellets of 21 Blue-tongues (Table 2) and indirect observations of feeding. Black Field Crickets *Teleogryllus commodus* are very abundant in grasslands in late summer and autumn and at these times were consumed by Blue-tongues. One adult Blue-tongue produced three faecal pellets packed exclusively with *T. commodus* remains. Millipedes (order Julidae) and Slaters *Porcellio scaber* were regularly encountered beneath surface stones and were also consumed. The introduced Common Garden Snail *Cantareus aspersa* is especially common in grasslands north of Melbourne (pers. obs.), and clusters of snails were frequently encountered on the underside of stones. Blue-tongues' affinity for garden snails is well known and yellow-brown stains around the mouths and chins of lizards that had been recently feeding on snails were observed during spring, summer and autumn (n = 17). The small orange fruit of the introduced Boxthorn *Lycium ferocissimus* was consumed by Blue-tongues in spring and autumn; eight Blue-tongues were observed with orange stains around their mouths, indicative of their having recently fed on these fruits. Hips of the introduced Sweet Briar *Rosa rubiginosa* and fruits of the native Tree Violet *Melicytus dentatus* and Volcanic Plains Tree Violet *M.* sp. aff. *dentatus* were consumed. These shrubs commonly grow amongst outcrops and dry-stone walls. Expelled seeds of these fruits were intact.

Activity and behaviour

Nineteen percent (22 of 116) of Blue-tongues recorded were in the open (active or basking); the rest were located beneath ground cover (n = 77) or concealed amongst ground vegetation (n = 17). Blue-tongues were observed active or basking in all but the winter months (June to August). The lowest air temperature that a Blue-tongue was observed basking (or active) was 14°C in late May. During winter and also during cooler periods at other times of the year, they were recorded beneath stones during daylight hours. Almost the same numbers of Blue-tongues were recorded from May to August inclusive as in the rest of the year (82 vs 81); this departs significantly from the expected frequencies (41 vs 122) based on equal numbers in each month ($\chi^2 = 21.2$, 1df, 2-tailed, $P < 0.0001$). This result reflects the greater ease of locating individuals beneath stones (when inactive) compared to when they are active. Only six Blue-tongues were recaptured and these were all found within 150 m of their initial point of capture.

Sloughing occurred during months when Blue-tongues were active. Individuals that had recently sloughed (or were about to slough) were located in January, February, April, May, November and December (n = 14). Restricting the sample to mature Blue-tongues, sloughing occurred in January, February and November (n = 7) and appears to coincide with a summer slough and a spring (post-brumation) slough. Some immature Blue-tongues likely slough a third and fourth time during a year, as occurs in Blue-tongues kept in outdoor enclosures north of Melbourne (pers. obs.).

Blue-tongues exploited artificial stone piles and dry-stone walls both for refuge and for foraging. This was indicated by the presence of lizards in stone cavities and within stone piles and walls during winter (n = 18) and observations of active Blue-tongues retreating into them when approached (n = 7). Three Blue-tongues were observed weaving in and out of stone walls whilst apparently foraging; one was observed attempting to consume a cricket. Where ground cover was sparse, individuals were observed to seek the shade of small shrubs, bushes and trees (Boxthorn, Tree Violet and Black Wattle) during the hottest part of the day in summer (n = 5). Two Blue-tongues were also found in the cool interior of stone walls on hot summer days.

Table 2. Dietary items consumed by Eastern Blue-tongues *Tiliqua scincoides scincoides* based on the content of faecal pellets from 21 individuals (n = the number of pellets containing each item).

Item	n	Comments
Black Field Cricket *Teleogryllus commodus*	9	Three pellets contained only cricket remains
Common Garden Snail *Cantareus aspersa*	4	Small shell fragments
Millipedes (Order Julidae)	6	One pellet contained the remains of more than one millipede
Slaters *Porcellio scaber*	2	One pellet contained more than 10 slaters
Boxthorn *Lycium ferocissimus*	5	One pellet contained these fruits exclusively
Tree Violet *Melicytus dentatus*/ Dwarf Tree Violet *M.* sp.aff. *dentatus*	6	Small numbers (< 10) of fruits in each pellet; two pellets included both spp.
Sweet Briar *Rosa rubiginosa*	2	Two hips were present in one pellet
Other:		
Grass leaves	3	Fragments
Sloughed-skin	1	Fragments

Almost all Blue-tongues were located singly in the field when active and all occurred singly beneath ground cover. The one exception involved two adults observed basking 1.5 m apart (but within clear view of each other) in mid-October.

Active or basking Blue-tongues reacted to being approached by either 'freezing' or retreating to the nearest cover (either grass tussocks, where they remained perfectly still, or beneath a stone). If individuals that stood their ground were approached at closer quarters (< 2 m), they would engage in the characteristic threat-display for which the species is well known: dorsoventral flattening of the body accompanied by mouth gaping, hissing and extruding the tongue. Agitated juveniles would often grasp objects placed near their heads and then perform a series of body-rolls. Some juveniles lifted their dorso-ventrally flattened bodies clear of the substrate and oriented it towards the perceived threat.

General condition and sources of mortality

Scale damage was observed in nine Blue-tongues, all except one of which were sexually mature adults (both sexes). In two individuals, there were extensive patches of necrotic scales. Pitting of the dorsal ('shoulder') scales was visible in all mature females that could be reliably sexed (n = 13) and is presumed to be the result of the male's 'grip-bite' during courtship and mating.

Introduced snake mites were recorded on 17 lizards, with some having large infestations around the neck, eyes, ears and body-limb junctures. As the processing of Blue-tongues was brief, it is certain that individuals with only minor infestations were overlooked and that this figure is an underestimation of the true frequency of occurrence. High frequencies of mites have been recorded in Blue-tongue populations from grasslands around Melbourne, although sample sizes were small (Watharow and Reid 2002).

Injuries and/or disease were noted in 13 lizards. Six of these were tail injuries in which the distal portion was missing (< 15 mm of regeneration; n = 5) or the tail had numerous kinks (n = 1). Single instances of cataract and respiratory disease were noted. Another three individuals were in poor condition, being emaciated and with extensive mite infestations. Eight dead Blue-tongues were found; the cause of mortality was evident in only two, where burnt carcasses were found within days of fires having burnt the grasslands. A live, but badly burned adult lizard was also recorded in recently burnt grassland. The stomach of a dead adult Eastern Brown Snake was found to contain juvenile Blue-tongue remains.

Discussion

This study is rather limited in extent and in scope but nonetheless it is possible to draw some general conclusions from it. Eastern Blue-tongues inhabiting the basalt plains around Melbourne are very common where sufficient ground cover exists. They consume both endemic and introduced plants and animals, are solitary, capable of rapid growth, moderately fecund (up to 17 young; Turner 1996) and potentially long-lived lizards (> 20 years; Shea 1998). Sources of mortality recorded in the present study include fire and large elapid snakes (see below). The ability of Blue-tongues to cope with changes to their habitat is indicated in this work by their use of dry-stone walls and artificial stone piles, their occurrence in severely degraded grassland, and the inclusion in their diet of introduced plant and animal species. How Blue-tongues have coped with habitat modification and loss due to urbanisation is not known, and although populations persist in some suburbs (pers. obs.), the degree to which these populations are reliant upon creeks, parklands, railway reserves, adjoining agricultural lands and other remnant habitat is unclear. A recent study of Blue-tongues inhabiting suburban regions around Sydney (Koenig *et al.* 2001; 2002) found that the species' survival may be due to, or is dependent on, (i) the existence of vegetated corridors, (ii) the repeated use of shelter sites, suburban gardens and large suburban blocks, (iii) the distribution of traffic movements and (iv) the availability of introduced food species (esp. Garden Snails). It seems likely that at least some of these criteria apply to Blue-tongue populations living on Melbourne's suburban fringe.

Blue-tongues are known to be omnivorous and opportunistic in their feeding habits (Shea 1998) and those inhabiting the basalt plains are no exception. Snails, millipedes and slaters are probably available year round since they are routinely found beneath surface stones accessible to Blue-tongues all year, but fruits and crickets are highly seasonal. Adult Black Field crickets probably constitute a significant food source for Blue-tongues in late summer and autumn when they are most abundant. Several other lizard species inhabiting the basalt plains exploit crickets as a food source: faecal pellets packed with cricket remains have also been observed in Cunningham's Skinks *Egernia cunninghami* (pers. obs.) and a dietary shift predominantly to crickets in late summer occurs in the Striped Legless Lizard *Delma impar* (Kutt *et al.* 1998). It is likely that Blue-tongues play a role in the dispersal of seeds of both endemic and introduced plant species that form part of their diet. The seeds are not chewed or crushed and some have been successfully germinated from faecal pellets (*Melicytus* spp.; pers. obs.). The consumption of Boxthorn and Tree Violet *Melicytus* spp. fruits is known also in basalt plains populations of *E. cunninghami* (pers. obs.) and in the Corangamite Water Skink *Eulamprus tympanum marnieae* (Peterson 1997).

Large elapid snakes are predators of Blue-tongues on the basalt plains. Valentic (1996) reported the regurgitation of a recently ingested adult Blue-tongue (SVL 265 mm) by an adult Eastern Brown Snake, and an adult Lowland Copperhead *Austrelaps superbus* was found to contain a recently ingested sub-adult Blue-tongue (R. Valentic, pers. comm.). Watharow (2002) also recorded a juvenile Blue-tongue in the diet of an Eastern Brown Snake from Eltham. These observations indicate that both adult and immature Blue-tongues are potentially vulnerable to predation by large elapids.

The gap in the monthly distribution of SVLs (Fig. 2) can be explained by the rate of growth of Blue-tongues. The potential for rapid growth in Blue-tongues has been demonstrated in captivity under conditions promoting continuous growth, with maturity reached by 10 months of age (Phillips 1986 Fig 2A; Walls 1996). Growth of Blue-tongues in the field appears, however, to occur more slowly. It is hypothesised that the two SVLs defining the gap (i.e. 170 and 210 mm) approximate the maximum and the minimum SVLs attained by successive cohorts at the beginning of their first, second and third winters respectively. Given that Blue-tongues around Melbourne are born in the period from February to April (see above; this is also consistent with the timing of parturition in local captive Blue-tongues kept outdoors; Turner 1996) and that in most years activity has largely ceased by the end of April, there is a growth period of, at most, three months between birth and their first winter. Given this short period of time and their small size at birth (SVL 64 – 104 mm; Turner 1996 and references cited therein) it is very unlikely that a juvenile could attain an SVL exceeding 170 mm before the onset of their first winter, but it is feasible by the onset of the second winter. Blue-tongues have usually resumed activity by the end of September, which means their first full growth period (October to April) spans approximately seven months. Using a neonate SVL of 90 mm and the smallest and largest growth rate figures obtained from recaptured individuals (7.3 and 13.5 mm/month), maturity (i.e. SVL $\geq$ 240 mm) can be attained by three and by two years of age respectively. Furthermore, the SVLs calculated at the onset of each winter avoid the observed gap: 112, 163, 214 mm (smallest growth rate); 131, 225 mm (largest growth rate); from the resumption of activity by late September there is approximately four months of growth until lizards reach three and two years of age respectively and by this time they have attained maturity). Clearly the rate of growth is critical to this argument, as is the assumption that it is constant; additional estimates of this rate are needed to test the hypothesis properly. The available data nonetheless indicate that sexual maturity is probably not attained until at least two years of age. Of course, alternative explanations for the gap in the SVL distribution are also possible, e.g. high juvenile mortality, inadequate sampling, etc., but require a more comprehensive study to determine their importance.

A mark-recapture study of Blue-tongues would be useful in determining the current status and long-term viability of populations inhabiting Melbourne's urban fringe and in abutting suburban regions. Information on Blue-tongue patterns of movement, growth rates and to what extent these are influenced by the availability of ground cover and diet would be useful in identifying factors critical to their survival in these regions.

Acknowledgements

Thanks are due to Rob Valentic for sharing his observations of this species with me, Glenn Shea for directing me to an on-line version of his thesis, and to the referee for making significant improvements to the manuscript.

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Received 17 September 2009; accepted 18 February 2010